Taking stock: An overview of research findings

Paper presented at the Ontario international symposium on teaching and learning in higher education, May 2008

Taking stock: teaching and learning research in higher education

Noel Entwistle *University of Edinburgh*

This paper takes stock of research into teaching and learning in higher education to provide a basis for considering ways of improving practice. Rather than setting about the utterly impossible task of a review of the total picture, I decided to narrow the focus. By setting out the main issues and then selecting a set of concepts that hang together sufficiently closely, it is hoped to offer a coherent research-based perspective on how teaching and learning environments influence the quality of student learning. A series of questions has been used to provide a structure for the paper, with a heuristic model being introduced later as a framework to support ways of thinking about teaching and learning. This conceptual framework is, however, just one 'take' on a complex and confusing research area, and inevitably draws mainly on the research I am most familiar with.

The starting point is the role research can play in improving teaching and learning, before moving on to definitions of high quality learning and how it can be brought about.

What do we expect research to be able to offer in guiding teaching practice?

All too often in education, pundits, and some researchers for that matter, seem to believe that they have found the method which all teachers should use. And policy makers have been urging educational researchers to discover 'what works' among the wide range of available teaching methods used in education, relying on 'research-based' or at least 'research-informed' techniques. But Dahllöf (1991), among others, has been strongly critical of attempts to identify 'best practice' in university teaching, arguing that:

> Too much attention is directed towards finding ... 'the best method', even though fifty years of educational research has not been able to support such generalisations. Instead, we should ask which method - or which combination of methods - is best ... for which goals, for which students, and under which conditions (p.148).

Thus, claims that e-learning or problem-based learning or communities of practice, or whatever else, is the way to encourage student learning cannot be substantiated. The effectiveness of teaching inevitably depends on its purpose and a host of interacting influences. Making use of just one general approach could never suit all topics, all subjects and all students, for all purposes. Nevertheless, we can expect to find certain general

principles of teaching and learning to guide thinking about effective practice within these more specific situations. And research can offer a conceptual framework and detailed findings to guide the way we think about teaching and learning in specific contexts.

Where can we find evidence on teaching and learning in post-secondary education?

There are some important questions to ask when considering how much weight to place on evidence or how valuable a theory will be for pedagogy. For example:

- *Is the theory derived from data or observations in an educational context?*
- *Is the theory presented in language that is readily intelligible to teachers?*
- *Can the aspects identified as affecting learning be readily changed?*
- *Does the theory have direct implications for teaching and learning in PSE?*
- *How realistic and practicable are the suggested implications?*
- *Will the theory spark off new ideas about teaching?*

It is not sufficient for a pedagogical theory simply to explain how people learn; it has also to provide clear indications about how to improve the quality and efficiency of learning.

In the early years of research into teaching and learning in PSE, the conceptual frameworks were derived almost entirely from mainstream psychology, and so lacked the ecological validity necessary to draw convincing implications for practice. Nevertheless, a sound understanding of the fundamentals of human learning is still important, as there are clear limitations on, for example, cognitive processing, as well as the particular strengths created by the flexible ways in which the brain is able to identify and combine related ideas. We need to be aware of these.

In more recent years, educational researchers have not only been carrying out studies within the everyday context of teaching and learning in PSE, but they have also been developing their own concepts and conceptual frameworks to supplement those offered by psychology and the other social sciences. One problem for education is that there has been a great deal of interest shown by psychologists and sociologists who are more concerned with developing general theories based on data collected in totally different contexts – experimental or social – and then seeking to apply them to education without fully understanding the limitations of their work, when different groups of learners or different types of learning are involved. One could cite as examples the development of programmed learning advocated by Skinner from his experiments on the conditioning of animals; the change in the teacher's role suggested by Rogers from his experiences in psychotherapy; and

the more recent ideas of Lave, based on the observations of apprentice tailors, but which are currently being seen as directly relevant to student learning. Such approaches have validity in their original context, of course, but when extrapolated to teaching and learning within PSE contexts, they may well overemphasize just one aspect, prove impracticable, or be just plain wrong in an educational context.

What research approaches are most effective?

It is also important to consider the research methodology used. The early approaches used in psychology – controlled experiments and questionnaire surveys – still figure prominently in the educational literature. Controlled experiments allow greater precision in investigating learning, but are almost impossible to carry out in everyday contexts of teaching and learning, particularly in PSE where introducing specific experimental interventions, or allocating students randomly to differing educational treatments, is generally unacceptable. The experiments often have to be carried out with small groups of volunteer students in constrained contexts, resulting in questionable generality or applicability to the real world.

Questionnaire surveys have the advantage of large samples, although the conditions under which the data are collected often lead to relatively low response rates, with the less successful students being overrepresented in the non-response category. There are also issues about the accuracy of any measurements made and the potentially misleading findings coming from students wishing to present themselves in the best possible light.

Since the 1970s, with the pioneering work of William Perry (1970) in Harvard and Ference Marton and his research team in Gothenburg (1976), much of the research into teaching and learning has involved in-depth interviewing of students and academics, and it is from this work that some of the most influential concepts and insights have emerged. These concepts have often been operationalised later through specially designed inventories, leading to increasingly complex statistical analysis of large data sets. These developments have made possible an interplay between survey and interview research, and the emergence of convergent and complementary findings from these contrasting methodological approaches has produced more convincing descriptions of teaching and learning in PSE.

In writing this paper, I have been aware of the differing emphases in research on teaching and learning in North America, and particularly in the USA, compared with those in Europe and Australasia. In the USA, there has been a substantial reliance on psychological conceptualisations – for example, linking learning strategies to elaboration in the memory

(Weinstein, Zimmerman & Palmer, 1988); drawing on psychological theories of motivation in relation to study strategies (Pintrich, & Garcia, 1994); using psychometric techniques to interpret students' evaluations of teaching (Marsh & Dunkin, 1997); and the application of ideas from social psychology to developing a college curriculum (Mentkowski *et al.,* 2000). In contrast, in what has come to be described as *student learning research,* much of the published material draws on concepts derived directly from educational contexts through interviews and inventory surveys (Biggs, 1987; Marton, Hounsell & Entwistle, 1997; Bowden & Marton, 1998; Prosser & Trigwell, 1999; Biggs, 2007). Although the concepts used in the States and elsewhere in the world often differ greatly, it is reassuring to find that the emerging conclusions about the relationship between teaching and learning are leading in very similar directions.

What is meant by 'high quality learning' in higher education?

Higher education, at least in the UK, is beset by terms intended to increase managerial control and increase the cost-effectiveness of the enterprise. Of course, governments have the responsibility to ensure that public money is used economically, but the measures put into place to monitor efficiency at times seem to run counter to what good teaching requires. There can be no doubt that we have to accept quality assurance, but the procedures that are used to implement it do raise concerns. If the value of PSE is judged mainly in terms of throughputs and outputs, if degrees are seen as branded commodities, and as teaching quality continues to be weighed less in career terms than research output, the notion of 'high quality learning' and the broad aims of a higher education can be pushed into the background.

In the research on teaching and learning in higher education there is an underlying assumption that high quality learning depends not just on pass or completion rates, but on the nature of the knowledge, skills and conceptual understanding that students have acquired during their degree course. In a recent large-scale British study - the ETL project (described later on) - it became clear that what faculty sought was not so much the overtaking of specific 'intended learning outcomes', as the development of more general *ways of thinking and practising* in the discipline or professional area (Anderson & Hounsell, 2007). They had a much broader view of what students were expected to achieve than could be expressed through disaggregating knowledge and understanding into unconnected bite-sized elements.

> These [ways of thinking and practising] were not confined to knowledge and understanding but also included subject-specific skills, an evolving familiarity with the values and conventions of scholarly communication within a discipline and an understanding of how new knowledge was generated in the field. (*Hounsell & Hounsell, 2007*: 98)

The danger with tightly specified outcomes is that it affects the quality of learning that then takes place. Drawing on the ideas of Habermas (1986), O'Brien (2008a) concludes that

> Subject matter that is construed, constructed and presented in instrumentalist, technical terms will facilitate… [equivalent] outcomes, effective for the mastery of key skills and competencies. In contrast, learning that requires the development of higher forms of knowledge and knowing, entailing transformation of perspective and worldview, relies on more sophisticated views of subject matter and of learning (p. 151).

Other writers have pointed out that universities and colleges currently need to prepare students for a rapidly changing world in which they experience *super-complexity* (Barnett, 2007) – situations in which no single agreed solution to problems can be reached. Increasingly, knowledge acquired in PSE can be no more than a springboard for coping with change and complexity in everyday life and the workplace, so students need to leave higher education with what Mentkowski and her colleagues (2000) call *learning that lasts,* which involves

> an integration of learning, development, and performance [during and after college]. It connotes change in behavior and flexibility in perspective, enduring commitments, and transformative elements that carry the individual forward through unexpected experiences, roles, and life events… [and] involves the whole person… to encompass the integration of learning with the development of the whole person. (*pp. xv, 11)*

Higher education should thus be concentrating on helping students to develop skills, attitudes, knowledge and understanding that will be of maximum value beyond academe; not just an induction into the world of work in a specific profession, but also an effective preparation for life in the 21st century. We need to remind government and management alike of the dangers of creating policies and quality assurance procedures that may unintentionally lose the essence of learning in higher education, while promoting a production model of efficient teaching. Somehow, the two aims in improving higher education need to become complementary, rather than oppositional.

What is known about human learning?

Going back to behaviourist psychology, we know that actions that are practised, and those that are systematically rewarded, are likely to be repeated in the future. While those conclusions now seem obvious, varied repetition in contrasting circumstances and reward

through prompt feedback about relative success remain crucially important, particularly in skill learning.

In relation to knowledge and understanding, cognitive psychology indicates the role of attention, and both short-term and long-term memory in learning. Without attention, little can be remembered, and the strength, the extent and the direction of that attention all affect learning. *Short-term memory* is not only limited in time, fading quickly, but also in size, allowing relatively few (7 ± 2) bits of information to be held there simultaneously, although we do develop ways of grouping related information to cope with more. This limitation can cause severe problems in student learning where too much material is presented within a short period of time, making it impossible for students to process it effectively, or to discover the relationships between the features being presented (Van Merriënboer, Kirschner & Kester, 2003).

Long-term memory is thought of as separable into the semantic aspect, where conceptually based material is stored, and the episodic, where events (episodes) are remembered. There are important cross-links between the two however; hence the efficacy of mnemonics and illustrations or anecdotes. And neurological research is making clear the importance of aroused interest in putting neurones on 'stand-by' and of the complex linkages and neuronal pathways that are experienced as memory and understanding (Zull, 2002; Hall, 2005). Repeated use of connections leads to myelinisation, insulating the links within a neural network and so making them more efficient. The experience of understanding, or a newly established skill, produces chemicals in the brain that produce a feeling of well-being, and so reinforce those activities.

The well-known biologist, Edward Wilson (1998), sums up these processes as follows:

> By spreading activation, the conscious mind summons information from the store of long-term memory... and holds it for a brief period in short-term memory. During this time it processes the information, ... while scenarios arising from the information compete for dominance... As the scenarios of consciousness fly by, driven by stimuli and drawing upon memories of prior scenarios, they are weighted and modified by emotion... which animates and focuses mental activity... What we call meaning is the linkage among neural networks created by spreading activation that enlarges imagery and engages emotion. *(Wilson, 1998: 119, 121, 122, 123, 126)*

Concept development depends on the formation of these linkages but incorrect or ineffective neural networks, once firmly established, are difficult to unpick afterwards. Greenfield (2008) suggests that immediate personalised feedback, through discussions about the processes of forming concepts and developing understanding, can help to embed the

kinds of learning for which teachers are aiming. However, implications derived from brain processes alone ignore the social nature of learning and the contexts within PSE.

What is known about students' ways of learning and studying?

A substantial body of research has accumulated over the last thirty years that has established how students go about learning and studying in higher education, with substantial agreement about the main differences, even though differing terminology is used. The concepts that emerge come at different levels of generality, with the broadest level describing goals and personal epistemology.

The research on students' goals contrasts the focus on the extrinsic rewards of qualifications alone with an *intrinsic orientation* towards the subject or the profession, seeking to understand the academic content and to become an expert in that area (Beaty, Gibbs, & Morgan, 1997). And, not surprisingly, the intrinsic orientation leads to higher quality learning.

Conceptions of knowledge and learning

An interview study by Perry (1970) was seminal in demonstrating that students developed *conceptions of knowledge* along common pathways during the college experience – beginning by seeing knowledge as either right or wrong and moving, first, towards a recognition of how evidence is used to reach conclusions, and beyond that to accept that knowledge is still developing and open to challenge, and so ultimately uncertain and socially constructed (relativism). He also showed that the acceptance of the implications of relativism came slowly and often with a difficulty not fully appreciated by faculty. Subsequent research has largely supported Perry's developmental scheme, but has suggested gender differences in the extent to which the learning is seen through personal or impersonal referents (Belenky *et al.*,1986) and has also led to debates about whether his scheme should be seen as a general trend or as differentiated across different facets of knowledge and across subject areas (Shommer-Aikins, 2002).

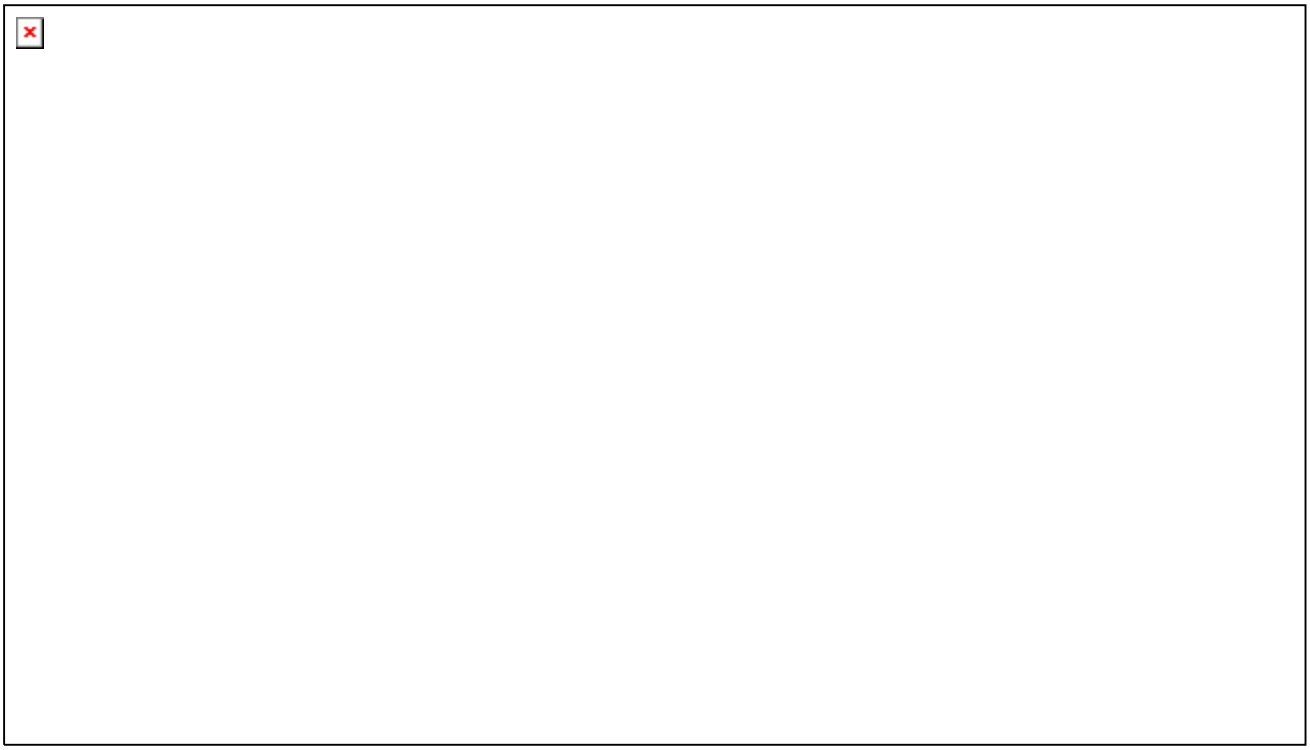

Figure 1 The development of conceptions of knowledge and learning

Changes in conceptions of knowledge are paralleled by equivalent development in students' *conceptions of learning*. Säljö (1979) found that students with little academic background saw learning in terms of memorising and reproducing knowledge, whereas those who had experienced higher education had more sophisticated conceptions involving seeking personal meaning, suggesting the trend illustrated in Figure 1. The diagram draws attention to a common feature of developmental schemes, namely that the more limited conceptions become integrated within the more sophisticated ones, so that, with the higher conceptions, students show a greater awareness of their own cognitive processes (*metacognition)* and can monitor their own activities in carrying out academic tasks *(metalearning)*.

Figure 1 also highlights the parallel development of conceptions of knowledge and learning and shows the existence, in both, of a crucial threshold at which an important qualitative change in conception takes place, affecting the ways in which students subsequently tackle their academic work (Entwistle, 2007). The similarity in these independent descriptions of conceptions suggests that the processes are intimately related within the experiences of students, even though they remain largely subconscious during the process of everyday studying.

Approaches to learning and studying

As we look at how students actually go about their academic work, the main distinction that has emerged can be traced back to the ideas of Ausubel and his colleagues (1978) who distinguished between *meaningful* and *rote learning* – extracting personal meaning from what is being learned or simply seeking to force it into the memory. They also noted that learning in educational contexts varies along another dimension, from reception learning to discovery learning, with much of the learning in schools or higher education involving meaningful reception learning from lectures or textbooks, rather than the active independent discovery of ideas. Whether the learning was meaningful or rote depended partly on the teaching and partly on the student.

In the literature, various labels have been attached to this distinction, but the terms introduced by Marton and his colleagues in Gothenburg (Marton, 1976; Marton & Säljö, 1997) – *deep and surface approaches to learning* – have the advantage of emerging directly from students' descriptions of their own learning, after they had read an academic text on which they expected to be questioned. The difference in the approaches is rooted in the students' intentions, as became clear in analysing the interviews.

> All our readings and re-reading, our iterations and reiterations, our comparisons and groupings, finally turned into an astonishingly simple picture. We had been looking for the answer to the question of why the students had arrived at qualitatively different ways of understanding the text as a whole. What we found was that the students who did not get 'the point', failed to do so simply because they were not looking for it. The main difference we found in the process of learning concerned whether the students *focused on the text itself or on what the text was about* - the authors intention, the main point, the conclusion to be drawn *(Marton & Säljö, 1997:43, original emphasis)*.

Students who had the intention to extract meaning for themselves engaged with the subject matter actively and generally reached a thorough understanding of the author's meaning, while those who used a surface approach were more concerned with trying to remember the answers to the questions they were expecting to be asked and so couldn't explain the author's meaning. Since the original naturalistic experiment, the distinction between deep and surface approaches has been widely confirmed across most subject areas (Richardson, 2000; Long, 2003), but the specific learning processes used to reach a deep understanding depend on the ways of thinking and practising that are fundamental to each specific area of study (Entwistle, forthcoming).

The research group in Gothenburg saw approaches to learning as relational – being affected by the teaching and learning environment experienced. As a result, individual students are found to vary their approach from course to course and even from topic to topic,

and yet often with an underlying consistency created by well-honed study habits, creating a relative stability at least within a specific course that enables general approaches to be estimated through self-report inventories (Entwistle & McCune, 2004). The decision to adopt a deep approach in a specific instance, however, will depend on being interested in the subject matter and having the necessary prior knowledge to be able to make sense of the study material. But actually reaching a deep understanding also depends on the amount and quality of the effort put into learning, now described as *organised effort* (TLRP, 2007), although earlier seen as a strategic approach (Entwistle & McCune, 2004).

Students adopting a deep approach may also differ in their preferences for particular learning strategies or *learning styles*. Some students – *holists* - prefer to tackle a topic by seeing it first as a whole, which can then be used to guide their developing understanding; others – *serialists* – are more comfortable with building up their understanding step-by-step through concentration of the details (Pask, 1988). Students' reactions to different forms of presentation, whether in lectures or writing, to some extent reflect their preferred styles of learning (Witkin *et al.,* 1977), but a full understanding of academic topics generally depends on an alternation between the two processes, as students examine the implications of evidence in detail and also the patterns of interconnections which relate ideas and concepts.

Survey research using inventories has shown that a deep approach seems to incorporate this interplay, with three sub-scales being directly involved - 'relating ideas', 'use of evidence' and 'interest in ideas'. The deep approach is also linked to an 'intrinsic orientation to the subject' in reasons for entering higher education, and a conception of learning as involving 'learning as transforming' (as opposed to reproducing) (Entwistle, 1998:19; Entwistle & Peterson, 2004). Vermunt (1998) also showed that students adopting a deep approach were likely to take greater responsibility for their own learning (self-regulation), while Entwistle, McCune & Hounsell (2003) found the deep approach associated, not only with monitoring studying but also with organised effort (see the analysis in Appendix 1).

While the correlational links between differing aspects of students' self-reports of their experiences of studying are clear, the developmental progression of students towards a deep approach during a degree course is neither as consistent nor as strong as might be hoped. It appears to be much easier to move students away from a surface approach than towards a deep approach (Lonka & Lindblom-Ylänne, 1996; Rodriguez & Cano, 2007).

Psychological research studies have identified other student characteristics that affect the outcomes of learning. Some of these exist prior to entering college, such as prior qualifications and previous knowledge: these have to be taken into account when planning and carrying out teaching, but cannot be changed. Other student characteristics have been firmly established prior to entry, such as general ability and fundamental personality traits, and are not normally seen as amenable to much change after late adolescence (Deary, 2000). But another group of characteristics, including specific abilities, self-confidence, interest, motivation and learning strategies, are all affected by experiences at university (Pintrich, Brown & Weinstein, 1994). More recently, it has been recognized that such groups of variables work in consort to bring about learning and, in particular, triads made up of cognitive, motivational and affective components. Perkins and Ritchhart (2004) have described a *thinking disposition,* which is made up of a triad of ability, inclination and alertness to situations that call for thinking. Following this line of argument, we can now suggest a *disposition to understand for yourself* in academic study, involving a symbiotic relationship between learning strategies and the confidence to use them effectively, willingness to put concentrated effort into reaching a personal understanding of academic topics, and also alertness to possibilities for learning provided within a learning environment and to opportunities for using understanding thereafter (Entwistle & McCune, in press). Such a disposition involves a continuing inclination to engage with learning so as to reach a personal understanding, and yet it can be stimulated, systematically encouraged and supported through the teaching and learning experiences provided (Janssen, 1996).

The nature of academic learning and understanding

The importance of developing conceptual understanding in higher education led to a series of studies on the nature of academic understanding in Edinburgh. A distinction has been made between the *target understanding* set up by the teacher and the *personal understanding* achieved by the student (Entwistle & Smith, 2002), and the development of this personal understanding has been seen in students' descriptions of their experiences as they prepared for final examinations. What was striking was the way understanding was described in terms of seeing a topic as a related whole, in which "all the pieces fitted together" (Entwistle & Entwistle, 1997). Indeed, by the end of their intensive revision, some students experienced a tightly integrated form of understanding that they reported seeing as an entity in their mind's eye – a *knowledge object* – which they then used to guide their exam answers

(Entwistle & Entwistle, 2003). Ongoing research in London is exploring the use of concept maps to identify the gradual development of understanding, seen in terms of the number and salience of the interconnections shown between concepts within a web (Hay, 2007).

Elsewhere, the continuing research of Marton and his collaborators led, first, to a series of studies looking at variations in how students had understood specific concepts (Marton & Booth, 1998), and more recently to a *variation theory* of learning within educational contexts (Marton, 2007). Conceptual learning depends on students being able to discern the *critical features* of a concept or topic, and the relationships between those features, simultaneously.

> We should… be clear about the difference between 'discerning' and 'being told'. Medical students, for instance, might be advised by their professor to try to notice the different features of their patients, such as the colour of the lips, the moisture of the skin, the ease of breathing, and so on. This is 'being told'. But in order to follow this advice the students must experience those features, and the only way to experience them is to experience how they can vary… By experiencing variation, people … become 'sensitized' to those aspects. This means that they are likely to see future events in terms of those aspects;… [so learning depends] on experiencing variation. (*Marton & Tsui, 2004: 10-11*)

Recent work has been exploring how variation theory can be used within higher education to teach problematic areas of a subject. Cope and Prosser (2005) identified the concept of an *information system* as problematic for students and interviewed students to identify the different ways in which they understood it. The researchers found several distinctive conceptions (phenomenographic categories of description – Marton & Booth, 1997): some saw an information system simply as something which retrieved information, while others viewed it as just a computer system linking individuals within an organisation. The target understanding for the teachers was a much more complex conception, involving the processes of gathering, disseminating, and communicating the various kinds of information required to support several different organisational functions. Students adopting a surface approach tended to focus on the limited conceptions: only with a deep approach were students likely to appreciate the more sophisticated interpretation.

A deep approach starts, as always, with an intention to work out the meaning for oneself and, in this instance, depended on alertness to the importantly different ways of describing an information system. For a full understanding to become possible, though, the teaching-learning environment had to provide opportunities for students to recognize the significance of these different perspectives through carefully varied tasks and explicit discussion of the critical features of the concept. In this way, students began to see the variations that exist in

the descriptions of information systems and, through that experience, to reach the required conceptual understanding.

> To improve the quality of students' outcomes, the educationally critical aspects… need to become explicit, thematised parts of the undergraduate curricula, textbooks, teaching strategies and learning activities. Importantly, students need to be aware, from the beginning of their studies, of the nature of the target level of understanding of the concept of an information system and how that understanding can be achieved… Learning tasks need to be designed… [to] make students aware of *the experience of learning about an information system.* (Cope & Prosser, 2005:366, original emphasis).

How do teaching and learning environments influence student learning?

This brings us to what we, as university or college teachers, can do to assist students to learn more effectively and more congenially. The first thing to note is that it is not so much the teaching-learning environment we provide that affects the learning approaches of individual learners, as their perceptions of it. Teaching-learning environments, nevertheless, do markedly affect overall student learning approaches, but the effects work in both directions (Richardson, 2007). Students already adopting deep approaches tend to view teaching designed to promote conceptual understanding favourably, while those having surface approaches react negatively to the same environments (Entwistle & Tait, 1990). And students giving high ratings to teaching effectiveness and the support provided for learning also report deep approaches linked to organised effort in studying (Entwistle, Nisbet & Bromage, 2005).

While the individual differences in perceptions of teaching are important to keep in mind, nevertheless the overall reactions of students to differing teaching-learning environments allow us to determine which aspects of those teaching arrangements are most likely to induce deep approaches, and so encourage conceptual understanding. Analyses of course evaluation forms from students have provided a clear idea about what aspects of teaching students find most helpful, with several studies being reported in Perry and Smart (1997). From these and other studies it seems clear that, in lectures, at least seven aspects are seen to be important – clarity, level, pace, structure, explanation, enthusiasm and empathy. The first four describe the essentials for effective lecturing, while the remaining '3-Es' seem to be the aspects most likely to encourage deep approaches in the students (Entwistle, 2000).

These studies focus exclusively on what happens in face-to-face teaching, but the most important conclusion from the research findings on the effects of teaching on learning is that all elements within a whole teaching-learning environment act together in affecting the

quality of learning. The encouragement of deep approaches depends on designing teaching, assignments and assessment that act synergistically to support student learning and understanding; and that synergy is crucial because even one important aspect 'out of sync' with the aims, or interfering with the effects of other components, can impede learning.

> Since the interaction between the learner and the learning environment depends on perceptions… the challenge in any educational programme is to prevent misperception and mismatch… Inappropriate approaches to learning are simply induced by teaching: just one piece of the 'jigsaw' that is out of place… may interfere with the relation between the learner and the content… Encouraging students to adopt deep approaches and to employ them holistically is… difficult because [all] the pieces need to fit together. (*Eizenberg*, *1988:196-7*)

Going even further, we begin to see the teaching-learning environment as an *interacting system,* an idea developed independently by Entwistle (1987; forthcoming) and Biggs (1993), drawing on soft-systems and general system theories respectively. The conclusions were almost identical: we can understand the outcomes of learning only by seeing students interacting with the whole teaching-learning environment provided by university teachers and institutions. External and institutional influences are largely unnoticed by students; they experience what has been called the 'inner teaching-learning environment', the domain over which staff have most control and that also has the greatest impact on the quality learning.

Figure 2 illustrates an inner teaching-learning environment described in the ETL project study (Entwistle, Nisbet & Bromage, 2005), using electronic engineering as an example. The diagram also indicates how each part of that environment contributes, in rather different ways, to the overall target understanding for a course. Later, after looking at subject area differences, we shall consider the ways in which this environment interacts with the characteristics of students to help explain the outcomes of learning.

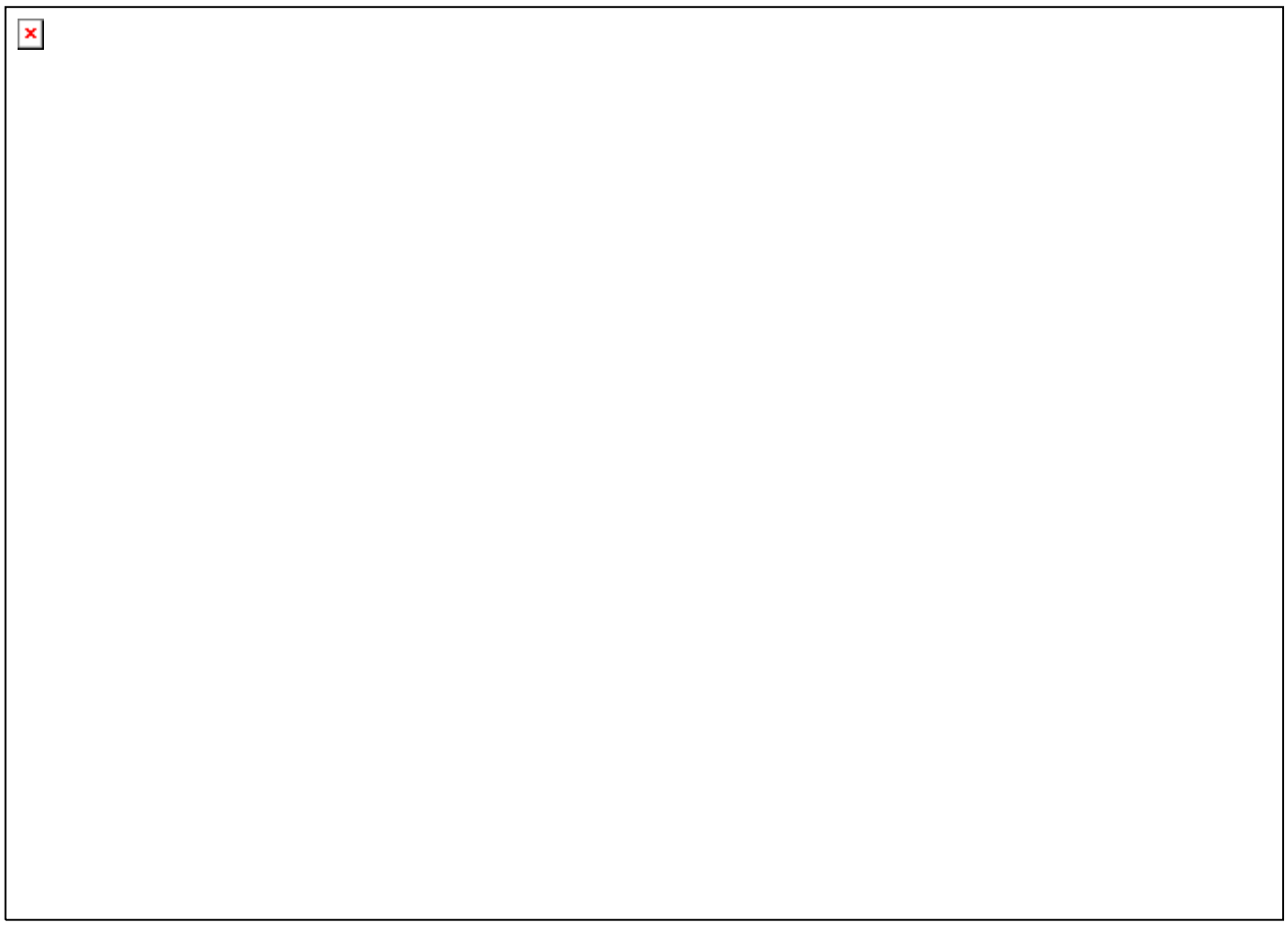

Figure 2 A teaching-learning environment experienced in electronic engineering (adapted from Entwistle, Nisbet & Bromage, 2005).

How does subject matter influence what constitutes effective teaching?

So far the research reviewed has sought to provide generalised conclusions about teaching and learning in higher education, but one of the main differences between schooling and PSE is the divergence between subjects and the ways in which they are taught. For educational researchers, it is particularly difficult to investigate teaching and learning within specific subject areas, as the subject-matter has to be understood at least as well as the undergraduates do. While there are vast numbers of studies carried out by academics about teaching within their own disciplines, they are mostly anecdotal reports of innovations in practice, often with little knowledge of the existing literature on teaching and learning or sufficient expertise in educational research methods. It is relatively rare to find studies that are well designed, conceptually sound and that also look in depth at the subject matter being taught. The picture is, however, becoming clearer, and the crucial implications for teaching and learning of the very different nature of academic disciplines and professional areas are now evident.

Differing epistemologies

Donald (1994) reported an influential series of studies across subject areas, interviewing teaching staff and students in five contrasting disciplines. At a broad level of analysis there were noticeable similarities, such as the need to validate knowledge either against observations in the physical world or against a consensus of scholarly interpretations, a search for coherence or internal consistency among evidence and arguments, and critical or analytic thinking in reaching interpretations of evidence (Donald, 1995). But there were also important differences both in the nature of the knowledge and in the match between the approaches to teaching adopted and the students' perceptions of the support they were receiving. In physics, the abstract nature of the subject and the overly theoretical explanations provided by their teachers created difficulties for the students, whereas the practical nature of engineering meant that the goals were easier to perceive. In psychology, students came to realize that the development of inferential skills was important. But what seemed to be generally lacking in the teaching was the explicit discussion of the ways of thinking characteristic of the discipline and how conclusions came to be validated.

Contrasting beliefs about teaching

Research into beliefs about teaching and typical approaches to teaching has found important differences among faculty, even within a discipline. One of the main distinctions is the extent to which the approach is *teacher-focused, content-oriented* or *student-focused, learning-oriented* (Prosser & Trigwell, 1999) – whether teachers concentrate on presenting the subject matter in terms of how they themselves see its structure and meaning, or whether they also recognize the importance of making that knowledge readily accessible to the students at the stage they have then reached.

The student-focused approach is more likely to keep the needs of the student firmly in mind and to encourage conceptual understanding by recognizing potential difficulties and stressing inter-connections within and between topics (Prosser & Trigwell, 1999). As all lecturers have to take account of content, there is a sense in which the student-focused approach will necessarily incorporate the content-focussed approach, but there seems to be a complication. In several studies, there is a gross disparity between the sciences and the humanities in the proportion of lecturers who have adopted the more inclusive student-focused approach. In one recent study, half of the science and engineering lecturers interviewed fell clearly into the teacher-focussed category, while among lecturers in the

humanities and social sciences over 70% were in the student-focused group (adapted from Prosser *et al.,* 2005, Table 4). Does this difference represent deficiencies in science teaching, or a contrast in how conceptual development is encouraged in science compared with the humanities?

In an earlier review of both school- and university-based research, and drawing on the Shulman's (1987) idea of *pedagogical content knowledge,* it was suggested that effective teachers were drawing from three overlapping knowledge bases – about the subject, about the range of teaching methods available to them, and about how students learn their subject (Entwistle & Walker, 2002). A recent study has begun to show how these three elements come together in different subject areas; how the nature of the subject area affects the way faculty think about pedagogy (O'Brien, 2008a, b). Knowledge in the sciences is more firmly established and more impersonal, while it remains more contested and people-centred in the social sciences. What does that imply for perceptions of pedagogy? Does the teaching of science really have to remain impersonal?

Prosser and his colleagues have recently come up with the intriguing finding that the main differences in approaches to teaching are also related to the way in which the subject itself is understood by the lecturer, either broadly integrated or in discrete packages.

> At one extreme, the subject is seen as a series of topics or issues with little or no attention being paid to the whole discipline. When the subject is seen in this way, lecturers tend to talk about 'delivering' discreet 'packages' of information to students… In such a scenario, there is little opportunity for students to see how they might integrate what they learn into a larger field of knowledge; what they know is likely to remain a series of isolated facts. At the other extreme, when the subject matter is seen by an academic as a coherent whole, students are more likely to be helped into a relationship with the field as a whole and to experience and develop, a personal understanding of that whole. (*Prosser, Martin & Trigwell, 2007: 56)*

In their study, social science lecturers were found to think in broader and more integrated ways than science lecturers about both disciplinary knowledge and ways of teaching (Prosser *et al.,* 2005, Table 4). It may be, then, that the ways science faculty tend to think about teaching remains both too impersonal and too atomistic to make it easy for many students to develop an integrated personal understanding, but that is also the way of thinking science requires. Still, a more conscious awareness of the nature of knowledge in their discipline, and its implications for effective teaching, would be valuable for them, and indeed for all faculty.

> If we want to change and develop the ways in which teachers approach their teaching and help their students to learn, we need to help them to think carefully about what they are teaching and how it relates to and coheres with the field as a whole. This is a particularly important issue for teachers new to teaching or teaching a topic for the first time. (Prosser *et al.*, 2005:153)

Identifying threshold concepts and dealing with troublesome knowledge

Another influential idea introduced during the ETL project, but developed much further since, is that of *threshold concepts* (Meyer & Land, 2003; 2006; Land, Meyer & Smith, 2008). These concepts have a crucial role to play within degree courses as they open up the subject for students by providing a gateway into a different and more powerful way of thinking about the subject: but one which often proves difficult for students to open.

> A threshold concept… is likely to be.. *transformative*, in that, once understood, its potential effect on student learning and behaviour is to occasion a significant shift in the perception of the subject… [It is also] *integrative*, that is exposes the previously hidden interrelatedness of something… [and it is] probably *irreversible*, in that the change of perspective occasioned by acquisition of a threshold concept is unlikely to be forgotten. (Meyer & Land, 2003, p. 4)

Recent work within the field of economics teaching and learning (Davies & Mangan, 2007) indicates that it is possible to identify a series of basic concepts in that subject area that then become integrated within overarching threshold concepts, and that webs of these higher-order concepts and theories can be used to map the knowledge domain that is to be taught, and so provoke discussions among faculty about better ways of teaching the subject.

> Threshold concepts… focus our attention on the relationship between big shifts in thinking in the subject and transformative changes that learners have to experience in their thinking. These changes are transformative in the sense that learners are not simply making connections between new learning and ideas they have already acquired. In order to truly understand the new idea – if it is a threshold concept - they must *re-work* prior understanding. (Davies & Mangan, 2007: 721)

Examples of how staff identify threshold concepts in their own disciplines, and how this process can transform their own pedagogical thinking, can be found in recent studies of threshold concepts (Land, Meyer & Smith, 2008). Essentially, discussion of threshold concepts can transform lecturers' ways of thinking about the nature of knowledge in their subject area and, in so doing, also affect their ideas about teaching and learning. In a recent study, O'Brien (1998a, b) used discussions between university teachers to focus on their thinking about a nominated threshold concept. Her work explored in depth the nature of 'pedagogical content knowledge', showing how teachers accounts of why particular aspects of their subject acted as threshold concepts, and how best to teach them, depended on

individual understandings of the epistemology of the discipline, as well as on distinctive personal theories about the nature of knowledge and its uses.

Considering troublesome knowledge in general, Perkins (2006, 2007) has argued that university teachers need to take the existence of 'trouble spots' in students' understanding more seriously. He suggests that there are different reactions from teachers when difficult areas are identified - to *blame* the students and continue to teach as before, to *focus* the teaching on the area of difficulty by teaching in the same way but working at it harder, and to try to *explain* the difficulty through a deeper understanding of what caused it and then changing the teaching accordingly. Perkins was also involved in the *Teaching for Understanding* project in schools, carried out in Harvard, where the main teaching aims were kept in students' minds through *throughlines.* These often took the form of major questions or issues such as, in history teaching, "How do we find out '*the truth*' about things that happened long ago?" and "How do we see through the bias in sources?", which created a framework for the most general understandings sought during the course (Wiske, 1998).

Teaching within the disciplines to encourage conceptual understanding

There have been important breakthroughs in teaching within specific subject areas through recognising difficulties encountered by students and devising imaginative ways of overcoming them. One influential example comes from physics, where Mazur (1997) had been trying to understand why many first-year students were doing badly and found the lectures boring. He found that students were concentrating on learning 'recipes' or problem-solving routines, which allowed them to arrive at solutions with little understanding of the underlying principles. He decided that traditional forms of lecture were the main cause of surface approaches to learning. He therefore tried to make students more actively involved in their own learning during lectures, and eventually devised what he called *peer instruction,* in which lecture-based instruction was interspersed with occasional five-minute concept tests. Students were required to note down an answer and then justify their answers to nearby students to increase student activity and involvement. This technique has been adapted to work with the computer-based Personal Response System (PRS) that displays analyses of the answers given by the whole class, allowing a more general discussion of any misconceptions emerging (Mazur, 2001).

A related approach, which also began in the sciences, has been encouraging faculty to make use of concept maps, not just in planning a new course or thinking about an existing

one, but also by training students to use them in their own studying in ways that make the connections between the concepts hierarchical and explicit. Students are also encouraged to discuss the differences in their concept maps and revise their diagrams repeatedly until they are satisfied with their understanding (Hay, 2007). This technique has recently been extended to a variety of disciplinary areas, but ongoing work suggests that, in the humanities, hierarchical structures are inappropriate and the links between concepts need to be explained, rather than just indicated in a few words (Hay, forthcoming). The success of concept maps depends on engaging the cognitive activities involved in developing personal understanding, processes whose importance is also supported through neurological research.

Innovations in other areas, such as problem-based learning (PBL) in medicine, have similar intentions in engaging students more actively with the main aims of the subject. As a recent study of medical students argues, what PBL can offer to students is a learning environment that encourages students to take on responsibility for their own learning and to think critically and deeply about abstract concepts in relation to everyday medical contexts and problems (Fyrenious, Wirell & Silén, 2007). One of the students in that study felt that the experience of PBL had fostered a different kind of understanding, one which made sense of theory within practice.

> If you don't know how to apply it in practice, you only have it in theory, then you haven't understood… If you can sort of think what happens practically, even if you don't have all the theory, so that you can apply what happens practically, then you have understood. And then you can draw parallels and be able to see relations and so on… But if you've only learned something really narrow in the book, and when you have to apply something that's not in the book, you find it difficult to understand because you… only know the language of the book. (p. 156)

PRS, PBL, and other similar discipline-based innovations have been adopted in other subject areas, but with varying success. Where independent, integrative reviews of evaluations of such teaching have been carried out (e.g. TLRP, 2004), the findings are almost always inconsistent - with good reason, as they are rarely able to compare like with like. The innovations are, quite sensibly, implemented in differing ways to fit in with local circumstances, but in the process prevent any easy comparison of outcomes. And it is not so much the use of any specific method in itself, but how it is implemented in relation to the broad aims of a particular course, that is important.

Research at school level has been looking at so-called 'powerful learning environments', which have been shown to influence the quality of learning (De Corte *et al.,* 2003). This approach encourages teachers to use authentic, open problems and learning materials

presented in a variety of formats. Teaching methods are intended to arouse interest, activate prior knowledge, clarify meanings, and model appropriate thinking strategies and reflective processes. Where new ways of learning or problem-solving are being introduced, these are *scaffolded* by providing detailed guidelines to follow. This support is then gradually removed so as to encourage subsequent self-regulation in learning. And, above all, students are encouraged to monitor their own strategies and discuss these with other students, so as to produce a classroom culture that encourages reflection on process.

What general principles are there for designing teaching-learning environments?

The earlier discussions made it clear why we cannot expect to find specific teaching methods that will 'work' in all, or even most, areas of PSE. Rather we have to take full account of the diversity that is found, both in institutions with contrasting intakes and purposes and among students with very different backgrounds and previous experiences of education. In the process, it is possible, however, to suggest guidelines for creating teaching-learning environments that are likely to encourage deep approaches among students, and so lead to high quality learning outcomes. But the specifics have to be left to individual course teams and individual teachers. From the work carried out in the ETL project, mentioned earlier, and in a more recent study by O'Brien (2008a, b), it is clear that university teachers typically embrace broad aims for student learning that guide their thinking about teaching methods. They concentrate on how to develop the characteristic ways of thinking and practising within their subject through the teaching methods adopted. Indeed, there appears to be an *inner logic of the subject and its pedagogy* (TLRP, 2007; Entwistle, forthcoming) linking the nature of knowledge in the discipline to the specific set of methods most likely to work well in helping students to learn.

This implies that much more weight should be given in educational development activities to encouraging academic staff to think critically about the nature of their subject area, to make explicit the ways of thinking and practising they want students to acquire and to identify the threshold concepts which open up the subject for students, but which often become stumbling blocks for them. Such critical consideration of the subject matter has been found to act as a threshold for faculty in clarifying their understanding of the relationship between teaching and learning, and making clearer which teaching methods are most likely to support the types of learning they want students to carry out (Land, Meyer & Smith, 2008).

While face-to-face teaching continues to play an important part in higher education, we have already argued that it is important to see how other aspects of the overall teaching-learning environment affect the quality of student learning. Figure 3 offers a heuristic map to summarize some of the more important influences on student learning that have been identified in the research.

The upper half of the model focuses on the characteristics of students, and these interact with the aspects of the teaching-learning environment shown in the lower half. The left-hand side shows the influences of students' abilities, knowledge and learning processes, linked to perceptions of meaning and relevance, and to the subject matter and how it is taught. The right-hand side brings in the effects of motives, feelings, and organised effort, associated with perceptions of the task requirements and other aspects of the teaching-learning environment, particularly assessment and feedback. It must be stressed, however, as we think about aspects of the model in more detail, that this separation between cognitive and emotional aspects, and between teaching and the learning environment, is just an analytic device intended to clarify the nature of the influences on learning, which are, in reality, closely inter-related.

Figure 3 Heuristic model of interacting influences on student learning

Student characteristics

All of the student characteristics shown in the model affect the outcomes of learning in one way or another, and interact with aspects of the teaching and the learning environment provided. As a result, they need to be kept in mind when planning and carrying out teaching. Some aspects, like interest, motivation and approaches to learning, are directly

affected by the teaching provided, while others, like intelligence and prior knowledge, as already mentioned, have to be taken into account in judging what is appropriate for a particular group of students.

Besides the specific influences on learning, the top half of the model also draws attention to certain broad characteristics that need to be kept in mind in thinking about the design of degree programmes. First, there is the crucial effect of *interest* in the subject and the willingness to put the requisite effort into learning. Then, there is the need for students to *monitor* the effects of their learning and studying processes, and to be aware of the opportunities provided by the various components within the teaching-learning environment for developing their understanding. And perhaps the most important aspect of monitoring learning involves *judging personal understanding* in relation to the academic targets being set, which brings us to the centre of the diagram and the most distinctive aims of university education – the development of conceptual understanding and characteristic ways of thinking and practising within the discipline.

The lower half of the model outlines some of the main components of a generalised teaching-learning environment. Although the analytic separation between teaching on the left and the learning environment on the right is artificial, nevertheless it serves to highlight the distinctive nature of the subject matter being taught and how that influences the choice of teaching methods. While the learning environment also, of course, depends on the subject matter, the influences shown on the right are somewhat less discipline specific, partly because of institutional policies about assessment procedures.

Subject content and how it is taught

The boxes on the left-hand side have mostly been covered in the previous discussion, but each box within the model relates to a series of critical features or defining characteristics that can be opened up, rather like an internet link, to explain what lies behind the label. The box describing 'teaching that encourages thinking and understanding' illustrates this process, although other aspects could also be included. And this second set of buttons could be opened up, in turn, to reveal the specific findings that underpin them.

One of the main problems facing faculty in planning their teaching these days is the diversity of previous knowledge and ability across students in their courses. Aiming at the average student no longer works well, because of these wider differences. Instead strategies are needed to provide material in different ways that will suit students with different starting

points and contrasting goals. One example of how that has been done comes from a physicist, Paul Walker, who described how

> Over time, I have developed a teaching approach which begins to satisfy simultaneously a tacit demand for content, for understanding of content, for relevance and applicability of that content, and yet still challenges [the students]… Within this *multipli-inclusive* approach, information is provided in logical order for those who want it… For students who need to relate to other course content or to the world, there is a thread of conversation making such links, often unexpected ones… [And] for students who seek to apply the knowledge, there is at least conversational reference to that - which… is not unusual. But an explicit awareness of inclusively serving the interests and learning approaches of a diversity of students seems to be much less common. *(Entwistle & Walker, 2002: 27-28)*

Although many features of good teaching have already been discussed, an obvious gap is the pervasive effect of information technology on teaching and learning. So far, however, there is a lack of research that brings together technological advances with the findings about teaching and learning in a coherent way. They seem at times to be marching to different drums: the one creating excitement about the latest way of presenting information or administering courses and the other focusing more on students' conceptual development and change. Although the literature described above has derived mainly from traditional approaches to teaching, nevertheless the principles emerging do seem to contain important messages for those devising e-learning environments (Ginns & Ellis, 2007). There is also a growing interest in *blended learning*, with its concern to find the most appropriate ways in which e-learning and traditional teaching can work together to support deep and meaningful learning (Garrison & Kanuka, 2004). And that is probably the most important trend to encourage in conventional universities and colleges, as the wholesale use of e-learning to deliver content knowledge no longer seems desirable. In publications on e-learning

> a lot of the hype has vanished and… the talk of '*death of traditional educational methods'…* has been replaced by a renewed realism about the importance of blending face-to face methods with e-learning, and that real learning is hard whatever methods are used – there are no 'silver bullets'… [Also it shows that] individual innovation by academic staff does not lead automatically to real educational progress, as it is random and not strategically focused. Nor does it lead to containment in costs but rather to an escalation in them. *(Haywood, 2004)*

Learning environment provided

The broader context that makes up the full teaching-learning environment involves the influences of the institution and departments or other academic divisions, of which faculty are generally all too well aware. Attempts to introduce innovations in either teaching or assessment can be encouraged or constrained by the resources provided and the types of

teaching rooms available, while institution-wide curriculum changes can sometimes be bitterly opposed within departments.

The attitudes of staff can also be seen in the ways in which they work collaboratively to create a teaching culture within a course team or department clearly influence student learning. Much has been made recently about *communities of practice* (Wenger, 1998), and course teams fit into that model. But the descriptions of these communities tend to stress the communality, whereas the reality often involves tensions and disagreements. Recently, Trowler (in press) has been exploring how these workgroups function within teaching-learning environments, teasing out the sociological aspects seen to govern their activities.

> In terms of theory, my thinking was much influenced by Lave and Wenger (1991). I was looking for different *communities of practice*… interacting with each other. What I found surprised and puzzled me. The problem was summed up by one head of department who said "There are more factions than people in my department". Where was the 'community of practice' here, then? What was being revealed largely centred around diversity and conflict, not 'legitimate peripheral participation': gentle induction into a shared set of understandings and practices. *(in press)*

In his analysis, Trowler focused on issues of leadership, authority and teaching ethos within departments and course teams, and how these affect the take-up of new approaches to teaching and learning, but those remain as a background to the current review. The teaching and learning policies and strategies evolved within institutions and policies clearly frame what is possible for faculty to achieve within their teaching activities, but how lecturers feel about them affects how these are implemented, and whether they will be successful. Students will generally not be aware of how these are influencing the teaching, but they are an everyday reality for the staff.

The remaining aspects highlighted in the heuristic model derive mainly from the ETL project, directed by Dai Hounsell and myself, within the Teaching and Learning Research Programme of the ESRC on *Enhancing teaching-learning environments in undergraduate courses* (TLRP, 2007). The researchers worked with course teams teaching 26 undergraduate modules in four contrasting subject areas – electronic engineering, biological sciences, economics and history – across 12 institutions. We interviewed staff and groups of students and also collected questionnaires from students before and after the course unit had been taught. The first questionnaire covered students' approaches to learning and studying and was similar to the version shown as Appendix 2. The second questionnaire asked about students' experiences and was a longer version of that shown as Appendix 3. Feedback on the analyses

of these data was given to course teams, with subsequent discussions usually leading to a 'collaborative initiative', involving some fine-tuning of the teaching to encourage greater student engagement in their learning. Equivalent data were then collected from the following year-group of students to explore their reactions to the modified teaching-learning environment provided.

Several of the concepts emerging from the project have already been mentioned – *ways of thinking and practising within the subject, threshold concepts* and the *inner logic of the subject and its pedagogy.* We also built on the notion of *constructive alignment* (Biggs, 1996) – matching teaching to constructivist aims – to examine what we called *congruence,* the 'goodness-of-fit' between the teaching as a whole and the course teams' targets of deep understanding and the development of the ways of thinking and practising. And that involved identifying any element which seemed to be interfering with such learning and also considering how the teaching seem to match the backgrounds, prior knowledge and aspirations of the students taking a module.

The questionnaire we designed to capture students' experiences of the teaching on the target module proved to have six main dimensions (see Appendix 3 scoring procedure), all of which were closely inter-related to create a factor describing a teaching-learning environment seen by students to support their learning. This factor showed quite strong correlations with factors indicating a deep approach and organised effort, and significant correlations with both surface approach (negative) and students' self-ratings of their achievement as indicated by the grades they had received to date (see Appendix 1 for details). This final factor was defined most strongly, not by grades but by perceptions of the pace, difficulty level and prior knowledge, and could be seen as a proxy for ability level, which it was not possible to measure directly.

The six scales describing students' experiences of teaching can be seen within the abbreviated version of the whole questionnaire shown as Appendix 3, and provided indications of where problems might lie. But the environment described by staff, and emerging from the group interviews with students, made the nature of the relationships with learning outcomes much clearer. For example, the damaging effect of inappropriate level and pace in lectures was apparent, particularly in electronic engineering where the notion of *delayed understanding* introduced by Scheja (2006) was found to be important. A lack of understanding of the main principles underlying the subject in the early stages of a course

created demoralisation, which led students to transfer their efforts to more rewarding course units (Entwistle, Nisbet & Bromage, 2005).

The importance of *course management* was striking in large first-year classes and, from the student perspective was most noticeable where the course team seemed not to be fully aware of what other members of the team were saying, and where tutors were not well prepared or seemed to be applying different standards in their marking.

The most consistent problem encountered related to the *feedback* provided on set work. The crucial importance of getting prompt comments and explanations from staff on the work submitted was mentioned repeatedly by students, and from a theoretical viewpoint is essential to complete any learning cycle. The competing pressures on faculty between teaching, research and administration, along with substantial increases in student numbers, are making it difficult to provide appropriate feedback in a full and timely way. The adverse effects of the lack of good feedback were clear, but the allocation of resources in departments meant that relatively more staff time was provided for final-year rather than first-year courses, and yet the need for feedback to inexperienced students, supplemented by support and guidance, is much greater than for those coming towards the end of their degree.

In the literature, the effects of *assessment* on approaches to studying are repeatedly stressed, as assessment is the main 'driver' of study behaviour and the form it takes strongly affects students' approaches to learning (Entwistle, 2000). The assessment that students experience during the course is 'formative' in the sense that it enables students to see what is required of them, but their perceptions of its purposes also affect their approaches to learning. Assessment tasks that are open-ended, encouraging engagement with the topic and requiring personal understanding, evoke a deep approach, while multiple-choice tests are notorious for pushing students into surface approaches (Scouller, 1998). But it is not the MCQ format itself that is to blame: items <u>can</u> demand understanding, but the vast majority of them do not (Gardiner, 1994), and students come to perceive MCQs in general as implying rote learning of detail. However, in our ETL project, we found that a careful combination of MCQs and short-answer questions (SAQs) focusing on conceptual understanding proved valuable.

> MCQs made the students revise the entire syllabus rather than concentrating on selected topics only. Most of students' concerns were centred around MCQs being badly written, ambiguously worded, or aimed at "catching them out". Students who obtained high exam scores on MCQs also scored high for SAQs, and the students' approaches to studying… were significantly related to their *overall* grades, rather

than to [those from] the different types of questions. Changing the examination format seemed to have set in motion a process of constructively aligning [the assessment], which resulted in conveying to the students a very clear sense of what was expected [in preparing for the exam] *(Reimann et al., 2007).*.

The final box describing the learning environment describes *support for individual learning and studying,* which is most at risk from the 'massification' of higher education. Meetings with individual students, and small-group tutorial classes, have become much less frequent, and yet discussion of students' developing understanding is crucial for high quality learning, from both pedagogical and neurological perspectives (Greenfield, 2008). As the teaching resources available for each student seem likely to continue to decline, the only alternatives seem to be an extended use of on-line facilities and the time-tabling of small-group sessions in which students discuss their work with each other.

'Best practice' in higher education

After this review of research into teaching and learning in PSE, what can be said about 'best practice' across disciplines? This term tends to be interpreted as what teaching methods should be used by faculty in order to improve the quality of learning. There is an answer, but it depends on a different understanding of 'best practice'. The research is suggesting that there is an inner logic of the subject and its pedagogy. In other words, approaches to teaching and the methods used to encourage conceptual understanding necessarily reflect the nature of knowledge and ways of thinking within a particular discipline. But there is also a *way of thinking about the pedagogy* that <u>can</u> be generalised, and there are actions that can be taken to embody that approach within the teaching-learning environments provided for students. So what is that way, and what are the actions?

Following the evidence presented in this paper, the way of thinking that emerges involves seeing the purpose of higher education as going beyond the acquisition of knowledge and skills, to recognize that for the demands of current society and employment, graduates need to have acquired a personal conceptual understanding of the main ideas and ways of thinking in their area of study so as to experience 'learning that lasts'. Only this will provide the flexibility in applying knowledge, skills and understanding that will suffice at a time of rapid change and 'super-complexity' in dealing with emerging issues and new problems.

In terms of what students have to develop during their degree courses, we should be pointing up the importance of their being able to recognize what is needed when meeting

a new challenge and to monitor their own processes of thinking in tackling the tasks they meet, as well as being aware of the opportunities available within their current environment to help in those tasks. This depends on having appropriately sophisticated conceptions of knowledge and learning, and the necessary disposition to seek a deep level of understanding. That disposition brings with it deep approaches in studying – thinking critically about evidence and looking for links between new ideas and previous knowledge – processes which, in alternation, can lead to tight, integrated forms of understanding, and to an awareness of their understanding as a knowledge object.

Such understanding can be encouraged by developing courses that set a broad agenda from the start, highlighting the ways of thinking and practising that are required and introducing broad questions as 'throughlines' that keep students focused on the importance of reaching an understanding for themselves. Using concept maps is also proving a good way of keeping the focus of personal understanding, while introducing topics in an open-ended way and setting authentic problems, rather than just repetitive book-based work, as well as giving choice in the assignments set, together help to set the tone for a learning-environment that will evoke deep approaches. In the past too little use was made of the students themselves as peer teachers or though discussion groups focused not just on topics of problems, but also on the processes of learning and working together collaboratively. Students also have to come to see that without putting in their own 'organised effort' and maintaining concentration, they will make little academic progress, but the student culture, and the need to earn money, competes with the students' readiness to put in the necessary time and focused effort. Nevertheless, encouraging a greater awareness of students' own responsibilities in learning can help.

Of course, university teachers also have responsibilities - to put in adequate time and effort into preparing their teaching and to be aware of potential difficulties facing students. They also have to devise ways of making their presentations interesting and set up learning environments that act synergistically to encourage and support a deep engagement with the subject. In devising a course along these lines, the starting point involves thinking critically about the nature of learning within the discipline or professional area, and establishing what students need to do in order to reach a broad, transferable understanding of that subject area. If 'intended learning outcomes' have to be set, then they should be made explicitly subservient to the broader aims established for the

degree course as a whole. Courses then need to be carefully monitored to identify potential trouble spots and, through understanding why these difficulties occur, establish ways of overcoming them. Introducing the notion of 'threshold concepts', which open up the subject in important ways, seems to trigger revealing discussions among faculty about the nature of knowledge in the discipline of professional area. Fortunately this approach leads discussions of pedagogical issues along a path that most teachers will find congenial to follow - even exciting - in contrast to the skill-based pedagogical training that can have the opposite effect.

In preparing for face-to-face teaching, the greater diversity in student backgrounds and knowledge needs to be kept in mind with 'multipli-inclusive' approaches to provide provocative ideas for those students already committed to learning the subject in a deep way, and enough simplicity and direct teaching for those who are less engaged. But the traditional qualities of good presentation remain: lectures should use language that is readily intelligible to the students, be pitched at the right level (or preferably offer multiple levels), develop at a pace that allows students to think about the ideas introduced, point up relevance and links between ideas, and contain a structure that is easy to follow. They should also make use of striking illustrations and examples to maintain attention and help students to discern the critical features on which understanding depends, using lively and clear explanations. It is also crucial for the lecturer to 'think out loud' in exemplifying the ways of thinking and practising in the subject, to show enthusiasm for the subject, and to demonstrate an alertness to difficulties that may emerge or explanations not understood, as well as a readiness to overcome them.

Face-to-face teaching is, however, just one facet of the whole teaching-learning environment, which includes the assessment procedures, the assignments set, the feedback provided to individual students, and the additional learning resources made available. And the social relationships that develop, between academic managers and staff, among faculty and students, as well as between them, all affect the quality of the learning culture. Moreover, it has to be recognized that every element of the teaching-learning environment has to support the overall aims of the course and act synergistically with all the others – to be *congruent* with them. It is much easier to lead students into surface approaches to learning than it is to persuade them to engage actively in developing their own understanding on the subjects they are studying, so it is useful to review courses to detect

any discordant elements, as was done in the ETL project. Indeed, the short version of the questionnaire used in that project (shown in Appendix 2) is one way of providing an evaluation that takes account of some of the most important features of a teaching-learning environment, if it is to support high quality learning. But, because of the *inner logic of the subject and its pedagogy,* there will be other aspects that will need to be covered.

In the end, 'best practice' is whatever helps students to engage more deeply with the subject and to become more actively responsible for their own learning, in the context of the goals of a particular institution, degree course, and group of students at a particular stage of their degree. And deciding what that involves that is no small challenge to faculty!

References

Anderson, C., & Hounsell, D. (2007). Konwledge practices" 'doing the subject' in undergraduate courses. *The Curriculum Journal*, 18, 463-478.

Ausubel, D. P., Novak, J. D., & Hanesian, H. (1978). *Educational psychology: A cognitive view.* (2nd Ed.). New York: Holt,. Rinehart & Winston.

Barnett, R. (2007). *A will to learn: being a student in an age of uncertainty.* Berkshire: Open University Press and Society for Research into Higher Education.

Beaty, E., Gibbs, G., & Morgan, A. (1997). Learning orientations and study contracts. In F. Marton, D. J. Hounsell, & N. J. Entwistle (Eds.), *The experience of learning* (2nd ed.) (pp. 72-88). Edinburgh: Scottish Academic Press. Out of print but available online at http://www.tla.ed.ac.uk/resources/EOL.html

Belenky, M. F., Clinchy, B. M., Goldberger, N. R., & Tarule, J. M. (1986). *Women's ways of knowing*. New York: Harper Collins.

Biggs, J. B. (1987). *Student approaches to learning and studying*. Hawthorn, Victoria: Australian Council for Educational Research.

Biggs, J. B. (1993). From theory to practice: a cognitive systems approach. *Higher Education Research and Development,* 12, 73-86.

Biggs, J. B. (1996). Enhancing teaching through constructive alignment. *Higher Education,* 32, 1–18.

Biggs, J. B. (2007). *Teaching for quality learning at university* (3rd ed.). Buckingham: Open University Press and SRHE.

Bowden, J., & Marton, F. (1998). *The university of learning: Beyond quality and competence in higher education.* London: Kogan Page.

Cope, C., & Prosser, M. (2005). Identifying didactic knowledge: An empirical study of the educationally critical aspects of learning about information systems. *Higher Education,* 49, 345-

372.

Dahllöf, U. (1991). Towards a new model for the evaluation of teaching. In U. Dahllöf, J. Harris, M. Shattock, A. Staropoli, & R. Veld (Eds.), *Dimensions of evaluation*. London: Jessica Kingsley.

Davies, P. & Mangan, J. (2007) Threshold concepts and the integration of understanding in economics, *Studies in Higher Education*, 32, 711-726.

Deary, I. J. (2000). *Looking down on human intelligence: from psychometrics to the brain.* Oxford: Oxford University Press.

De Corte, E., Verschaffel, L., Entwistle, N. J., & van Merriënboer, J. (Eds.) (2003). *Powerful learning environments: Unravelling basic components and dimensions.* Oxford: Pergamon.

Donald, J. G. (1994). Science students' learning: ethnographic studies. In P. R. Pintrich, D. R. Brown, & C-E Weinstein (Eds.), *Student motivation, cognition and learning: Essays in honor of Wilbert J. McKeachie* (pp. 79-112). Hillsdale, NJ.: Lawrence Erlbaum.

Donald, J. G. (1995). Disciplinary differences in knowledge validation. In N. Hativa & M. Marincovich (Eds.) *Disciplinary differences in teaching and learning: Implications for practice.* San Francisco, CA.: Jossey Bass.

Eizenberg, N. (1988). Approaches to learning anatomy: developing a programme for preclinical medical students. In P. Ramsden (Ed.), *Improving learning: New perspectives* (pp. 178-198). London: Kogan Page

Entwistle, N. J. (1987). A model of the teaching-learning process. In J. T. E. Richardson, M. W. Eysenck & D. Warren-Piper (Eds.) *Student learning: research into education and cognitive psychology* (pp. 13-28). Buckingham: SRHE and Open University Press.

Entwistle, N. J. (1998). Motivation and approach to learning: motivation and conceptions of teaching (pp. 15-24). In S. Brown, S. Armstrong, & G. Thompson (Eds.), *Motivating students.* London: Kogan Page.

Entwistle, N. J. (2000). Approaches to studying and levels of understanding: The influences of teaching and assessment. In J. C. Smart (Ed.,) *Higher education: Handbook of theory and research. Volume XV.* New York: Agathon Press.

Entwistle, N. J. (2007). Conceptions of learning and the experience of understanding: thresholds, contextual influences, and knowledge objects. In S. Vosniadou, A. Baltas & X. Vamvakoussi (Eds.), *Reframing the conceptual change approach in learning and instruction* (pp. 123-144). Oxford: Elsevier.

Entwistle, N. J. (2009). *University teaching and student learning: Deep approaches and conceptual understanding.* Basingstoke, Hampshire: Palgrave Macmillan.

Entwistle, N. J., & Entwistle, A. C. (1997). Revision and the experience of understanding. In F. Marton, D. J. Hounsell, & N. J. Entwistle (Eds.), *The experience of learning* (2nd ed.) (pp. 145-158). Edinburgh: Scottish Academic Press. Out of print but available online as above.

Entwistle, N. J. & Entwistle, D. M. (2003). Preparing for examinations: The interplay of memorising and understanding, and the development of knowledge objects. *Higher Education Research and Development*, 22, 19-42.

Entwistle, N. J., & McCune, V. (2004). The conceptual bases of study strategy inventories. *Educational Psychology Review,* 16, 325-346.

Entwistle, N. J., & McCune, V. (2009). The disposition to understand for yourself: Learning strategies, effort and alertness to context in studying. In L-F. Zhang & R. J. Sternberg (Eds.), *Perspectives on the nature of intellectual styles.* (pp.29-62). New York: Springer.

Entwistle, N. J., McCune, V., & Hounsell, J. (2003). Investigating ways of enhancing university teaching-learning environments: Measuring students' approaches to studying and perceptions of teaching. In E. De Corte, L. Verschaffel, N. Entwistle, & J. van Merriënboer (Eds.), *Powerful learning environments: Unravelling basic components and dimensions* (pp. 89-108). Oxford: Elsevier Science.

Entwistle, N. J., McCune, V., & Scheja, M. (2006).Student learning in context: Understanding the prhenomenon and the person. In L. Verschaffel, F. Dochy, M. Boekerts, & S. Vosniadou (Eds.), *Instructional psychology: Past, present and future trends* (pp. 131-148). Amsterdam: Elsevier.

Entwistle, N. J., Nisbet, J. B., & Bromage, A. (2005). *ETL project. Subject overview report: Electronic engineering.* Posted at http://www.ed.ac.uk/etl

Entwistle, N. J., & Peterson, E. R. (2004). Conceptions of learning and knowledge in higher education: Relationships with study behaviour and influences of learning environments. *International Journal of Educational Research*, 41, 407-428.

Entwistle, N. J., & Smith, C. A. (2002). Personal understanding and target understanding: mapping influences on the outcomes of learning. *British Journal of Educational Psychology*, 72, 321-342.

Entwistle, N. J., & Tait, H. (1990). Approaches to learning, evaluations of teaching, and preferences for contrasting academic environments. *Higher Education,* 19, 169-194.

Entwistle, N. J., & Walker, P. (2002). Strategic alertness and expanded alertness within sophisticated conceptions of teaching. In N. Nativa & P. Goodyear (Eds.), *Teacher thinking, beliefs and knowledge in higher education* (pp. 15-40). Dordrecht: Kluwer Academic Publishers.

Fyrenius, A., Wirell, S., & Silén, C. (2007). Student approaches to achieving understanding – approaches to learning revisited. *Studies in Higher Education,* 32, 149-165.

Gardiner, L. F. (1994). *Redesigning higher education: Producing dramatic gains in student learning*. Report No. 7. Washington, D.C.: Graduate School of Education and Human Development, The George Washington University.

Garrison, D. R. & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential. *The Internet and Higher Education,* 7, 95-105.

Ginns, P., & Ellis, R. (2007). Quality in blended learning: exploring the relationships between on-line and face-to-face teaching and learning. *The Internet and Higher Education,* 10, 53-64.

Greenfield, S. (2008). Networking pays off. *Times Educational Supplement Magazine,* 18th January, 2008, 36-37

Habermas, J. (1986). *The theory of communicative action*. Boston, Mass: Beacon Press.

Hall, J. (2005). Neurscience and education: What can barin science contribute to teaching and learning? *Spotlight, No. 92*. Glasgow: University of Glasgow, SCRE Centre.

Hay, D. B. (2007). Using concept mapping to measure deep, surface and non-learning outcomes. *Studies in Higher Education,* 32, 39-57.

Hay, D. B. (forthcoming). Understanding what we know: a declarative approach to concept mapping. Contact david.2.hay@kcl.ac.uk

Haywood, J. (2004). A short review of e-learning in UK higher education. Internal document, University of Edinburgh.

Hofer, B. K., & Pintrich, P. R. (2002). *Personal epistemology: The psychology of beliefs about knowledge and knowing*. Mahwah, NJ: Lawrence Erlbaum & Associates.

Hounsell, D., & Hounsell, J. (2007). Teaching-learning environments in contemporary mass higher education. In N. J. Entwistle & P. D. Tomlinson, (Eds.), British Journal of Educational Psychology Monograph Series II, Number 4 – *Student learning and university teaching* (pp. 91-111). Leicester: British Psychological Society.

Janssen, P. J. (1996). Studaxology: the expertise students need to be effective in higher education. *Higher Education,* 31, 117-141.

Land, R., Meyer, J. H. F., & Smith, J. (2008). *Threshold concepts within the disciplines.* Rotterdam: Sense publishers.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Long, W. F. (2003). Dissonance detected by cluster analysis of responses to the *Approaches and Study Skills Inventory for Students*, *Studies in Higher Education*, 28 21-36

Lonka, K. & Lindblom-Ylänne, S. (1996). Epistemologies, conceptions of learning, and study practices in medicine and psychology. *Higher Education, 31*, 5-24.

Marsh, H. W., & Dunkin, M. J. (1997). Students' evaluations of teaching: A multidimensional perspective. In R. P. Perry, & J. C. Smart (Eds.)(1997). *Effective teaching in higher education: Research and practice.* New York: Agathon Press.

Marton, F. (1976). What does it take to learn? Some implications of an alternative view of learning. In N. J. Entwistle (Ed.), *Strategies for research and development in higher education* (pp. 32- 43). Amsterdam: Swets & Zeitlinger.

Marton, F. (2007). Towards a pedagogical theory of learning. . In N. J. Entwistle & P. D. Tomlinson, (Eds.), British Journal of Educational Psychology Monograph Series II, Number 4 – *Student learning and university teaching* (pp. 19-30). Leicester: British Psychological Society.

Marton, F., & Booth, S. (1997). *Learning and awareness.* Mahwah, NJ.: Lawrence Erlbaum.

Marton, F., Hounsell, D. J. & Entwistle, N. J. (Eds.). *The experience of learning: Implications for teaching and learning in higher education.* (2nd ed.) Edinburgh: Scottish Universities Press. Out of print but available online at http://www.tla.ed.ac.uk/resources/EOL.html.

Marton, F., & Säljö, R. (1997). Approaches to learning. In F. Marton, D. J. Hounsell & N. J. Entwistle (Eds.), *The experience of learning* (2nd ed.) (pp. 39-58). Edinburgh: Scottish Academic Press - out of print, but available as above.

Marton, F., & Tsui, A. B. M. (2004). *Classroom discourse and the space of learning*. Mahwah, NJ: Lawrence Erlbaum.

Mazur (1997). Understanding or memorization: are we teaching the right thing? In J. Wilson (Ed.). *Conference on the introductory physics course* (pp. 113-123). New York: Wiley.

Mazur, E. (2001). Peer instruction: ten years of experience and results. *American Journal of Physics*,

Mentkowski & associates (2000). *Learning that lasts: Integrating, learning, development, and performance in college and beyond.* San Francisco, CA: Jossey-Bass.

Meyer, J. H. F., & Land, R. (2003). *Threshold concepts and troublesome knowledge: Linkages to ways of thinking and practising within the disciplines.* ETL Project, Occasional Report 4, available at http://www.tla.ed.ac.uk/etl/docs/ETLreport4.pdf.

Meyer, J. H. F., & Land, R. (2006). (Eds.) *Overcoming barriers to student understanding: Threshold concepts and troublesome knowledge*. London: Routledge.

O'Brien, M. (2008a). *Teaching as translation: An investigation of university teachers' pedagogical content knowledge, reasoning and intention.* Ph.D thesis submitted in the School of Education and Professional Studies, Griffith University, Queensland, Australia.

O'Brien, M. (2008b). Threshold concepts for university teaching and learning: a study of troublesome knowledge and transformative thinking in the teaching of threshold concepts. In J.H.J. Meyer, R. Land and J. Smith (Eds). *Threshold concepts in the disciplines* (pp. 289-306). Netherlands: Sense Publishers.

Pask, G. (1988). Learning strategies, teaching strategies and conceptual or learning style. In Schmeck, R. (ed.), *Learning strategies and learning styles* (pp. 83-100). New York: Plenum Press.

Perkins, D. (2006). Constructivism and troublesome knowledge. In J.H.F. Meyer & R. Land, (Eds.), *Overcoming barriers to student understanding. Threshold concepts and troublesome knowledge* (pp. 33-47). London: Routledge.

Perkins, D. N. (2007). Theories of difficulty. In N. J. Entwistle & P. D. Tomlinson, (Eds.), British Journal of Educational Psychology Monograph Series II, Number 4 – *Student learning and university teaching* (pp 31-48). Leicester: British Psychological Society.

Perkins, D. N., & Richhart, R. (2004). When in good thinking? In D. Y. Dai & R. J. Sternberg (Eds.), *Motivation, emotion and cognition: Integrative perspectives on intellectual functioning and development* (pp. 351-384). Mahwah, NJ.: Lawrence Erlbaum.

Perry, R. P., & Smart, J. C. (Eds.)(1997). *Effective teaching in higher education: Research and practice.* New York: Agathon Press.

Perry, W. G. (1970). *Forms of intellectual and ethical development in the college years: A scheme.* New York: Holt, Rinehart and Winston.

Pintrich, P. R., & Garcia, T. (1994). Self-regulated learning in college students: Knowledge, strategies and motivation. In P. R. Pintrich, D. R. Brown, & C-E. Weinstein (Eds.), *Student motivation, cognition and learning. Essays in honor of Wilbert J. McKeachie.* Hillsdale, NJ.: Lawrence Erlbaum.

Pintrich, P. R., Brown, D. R, & Weinstein, C-E. (Eds.) (1994). *Student motivation, cognition and learning. Essays in honor of Wilbert J. McKeachie.* Hillsdale, NJ.: Lawrence Erlbaum.

Prosser, M., Martin, E., & Trigwell, K. (2007). Academics' experiences of their teaching and of their subject matter. In N. J. Entwistle & P. D. Tomlinson, (Eds.), *British Journal of Educational Psychology Monograph Series II, Number 4* – Student learning and university teaching (pp. 49-60). Leicester: British Psychological Society.

Prosser, M., Martin, E., Trigwell, K., Ramsden, P., & Lueckenhausen, G. (2005). Academics' experiences of understanding of their subject matter and the relationship to their experiences of teaching and learning. *Instructional Science, 33*, 137-157.

Prosser, M., & Trigwell, K. (1999). *Understanding learning and teaching: The experience in higher education.* Buckingham: Open University Press and the Society for Research into Higher Education.

Reimann, N., Land, R., Meyer, J. H. F & Rui, X. (2007). *ETL project. Subject overview report: Electronic engineering*. Posted at http://www.ed.ac.uk/etl

Richardson, J. T. E. (2000). *Researching student learning: Approaches to studying in campus-based and distance education*. Buckingham: SRHE & Open University Press.

Richardson, J. T. E. (2007). Variations in student learning and perceptions of academic quality. In N. J. Entwistle & P. D. Tomlinson, (Eds.), British Journal of Educational Psychology Monograph Series II, Number 4 – *Student learning and university teaching* (pp. 61-72). Leicester: British Psychological Society.

Rodriguez, L., & Cano, F. (2007). The learning approaches and epistemological beliefs of university students: a cross-sectional and longitudinal study. *Studies in Higher Education*, 32, 647-667.

Scheja, M. (2006). Delayed understanding and staying in phase: Students' perceptions of their study situation. *Higher Education*, *52*, 421-445.

Schommer-Aikins, M. (2002). An evolving theoretical framework for an Epistemological Belief System. In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemologies: The psychology of beliefs about knowledge and knowing* (pp. 103-118). Mahwah, NJ: Lawrence Erlbaum.

Scouller, K. (1998) The influence of assessment method on students' learning approaches: Multiple choice question examination versus assignment essay. *Higher Education,* 35, 453-452

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Educational Researcher,*15(2), 1-22.

Säljö, R. (1979). *Learning in the learner's perspective. I. Some common-sense conceptions.* (Report 76). Gothenburg: University of Gothenburg, Department of Education.

Teaching & Learning Research Programme (TLRP) (2004). The effects of problem-based learning. 1 a pilot systematic review and meta-analysis. *Research Briefing* No.8, available on the internet at http://www.tlrp.org/

Teaching & Learning Research Programme (TLRP) (2007). Learning and teaching at university: The influence of subjects and settings. *Research Briefing* No.31, available on the internet at http://www.tlrp.org/

Trowler, P. (in press). *Cultures and change in higher education.* Basingstoke, Hampshire: Palgrave Macmillan.

Van Merriënboer, J. J. G., Kirschner, P. A., & Kester, L. (2003). Taking the load off a learner's mind: Instructional design for complex learning,. *Educational Psychologist,* 38, 5-13.

Vermunt, J. D. (1998). The regulation of constructive learning processes. *British Journal of Educational Psychology,* 68¸ 149-171.

Weinstein, C-E., Zimmerman, S. A.,& Palmer, D. A. (1988). Assessing learning strategies: The design and development of the LASSI. In C-E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), *Learning and study strategies: Issues in assessment, instruction, and evaluation.* London: Academic Press.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity.* Cambridge: Cambridge University Press.

Wilson, E. O. (1998). *Consilience*. London: Little, Brown & Co.

Wiske, M. S. (Ed.) (1998). *Teaching for understanding: Linking research with practice.* San Francisco: Jossey-Bass.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1977). Field-dependent and field-independent cognitive stydles and their educational implications, *Review of Educational Research*, 47, 1-64.

Zull, J. E. (2002). *The art of changing the brain: Enriching the practice of teaching by exploring the biology of learning.* Sterling, VA: Stylus Publishing.

Appendix 1 Factor analysis of scales and inter-correlations between factors from the ETL project

		Total sample (N = 4538)				
Scales	***Factor***	***I***	***II***	***III***	***IV***	***V***
Reasons for taking the degree						
Interest in the subject			**.46**			
Lack of purpose					**.43**	
Reasons for taking the module						
Interest in its content			.33			
Expected easiness					(.24)	(.28)
Prior general approaches to studying						
Deep approach		**(**.25)	**.84**			
Organised effort				**.72**		
Surface approach					**.71**	
Specific approaches to studying the actual module						
Deep approach			**.49**			
Organised effort				**.81**		
Surface approach					**.57**	(**-** .23)
Perceived demands within the module						
Prior knowledge easy						**.49**
Pace and difficulty level easy						**.71**
Experiences of teaching						
Aims and congruence		**.64**				
Choice allowed		**.49**				
Teaching for learning		**.67**				
Set work and feedback		**.69**				
Staff enthusiasm and support		**.64**				
Interest and enjoyment		**.56**				
Self-ratings on achievements						
Acquisition of knowledge and skills		**.56**				
General level of performance				(.22)		**.40**

Inter-correlation between factors		**I**	**II**	**III**	**IV**	**V**
I	*Experiences of teach-learning environment*	. --	.39	.35	- .20	.21
II	*Deep approach*		--	.41	- .31	.09
III	*Organised effort*			.--	**-** .26	.15
IV	*Surface approach*				. --	**-** .10
V	*Self-rated achievement*					--

Pattern matrix after maximum likelihood analysis with oblique rotation to simple structure

Variance extracted 51.9% Loadings > .40 are highlighted; < .30 omitted unless indicative

Appendix 2 A S S I S T (Short Version)

Approaches and Study Skills Inventory for Students

This questionnaire has been designed to allow you to describe, in a systematic way, how you go about learning and studying. The technique involves asking you a substantial number of questions which overlap to some extent to provide good overall coverage of different ways of studying. Most of the items are based on comments made by other students.

Please respond truthfully, so that your answers accurately describe your **actual** ways of studying, and work your way through the questionnaire quite **quickly**, making sure that you give a response to **every item.** In deciding your answers, think in terms of **this particular lecture course.**

It is also very important that you answer **all** the questions by circling a number: please check that you have.

5 means agree (√) *4 = agree somewhat (√?)* *2 = disagree somewhat (x?)* *1 = disagree (x).*

Try not to use 3 = unsure (??), unless you really have to, or if it cannot apply to you or your course.

		√	√?	??	x?	x
1.	I often have trouble in making sense of the things I have to remember.	5	4	3	2	1
2.	When I'm reading an article or book, I try to find out for myself exactly what the author means.	5	4	3	2	1
3.	I organise my study time carefully to make the best use of it.	5	4	3	2	1
4.	There's not much of the work here that I find interesting or relevant.	5	4	3	2	1
5.	I work steadily through the term or semester, rather than leave it all until the last minute.	5	4	3	2	1
6.	Before tackling a problem or assignment, I first try to work out what lies behind it.	5	4	3	2	1
7.	I'm pretty good at getting down to work whenever I need to.	5	4	3	2	1
8.	Much of what I'm studying makes little sense: it's like unrelated bits and pieces.	5	4	3	2	1
9.	I put a lot of effort into studying because I'm determined to do well.	5	4	3	2	1
10.	When I'm working on a new topic, I try to see in my own mind how all the ideas fit together.	5	4	3	2	1
11.	I don't find it at all difficult to motivate myself.	5	4	3	2	1
12.	Often I find myself questioning things I hear in lectures or read in books.	5	4	3	2	1
13.	I think I'm quite systematic and organised when it comes to revising for exams.	5	4	3	2	1
14.	Often I feel I'm drowning in the sheer amount of material we're having to cope with..	5	4	3	2	1
15.	Ideas in course books or articles often set me off on long chains of thought of my own.	5	4	3	2	1
16.	I'm not really sure what's important in lectures, so I try to get down all I can.	5	4	3	2	1
17.	When I read, I examine the details carefully to see how they fit in with what's being said.	5	4	3	2	1
18.	I often worry about whether I'll ever be able to cope with the work properly.	5	4	3	2	1

Thank you very much for spending time completing this questionnaire: it is much appreciated.

If you would like to make any additional comments about your ways of studying, please use the back of this sheet.

Scoring Key for ASSIST (Short Version)

Scoring procedure

The subscales are formed by adding together the responses on the items in that subscale and dividing the total by the number of items in that scale to give a score out of 5. For example, Deep approach = D02 + D06 +D10 + D12 +D15 + D17. The other two scale scores can then be formed in the same way. Scoring can be carried out by computer, using a program such as SPSS. Each item is set as a variable and then a subscale total is produced by creating a new variable by summing the items.

Deep Approach

D02 When I'm reading an article or book, I try to find out for myself exactly what the author means.

D06 Before tackling a problem or assignment, I first try to work out what lies behind it.

D10 When I'm working on a new topic, I try to see in my own mind how all the ideas fit together.

D12 Often I find myself questioning things I hear in lectures or read in books.

D15 Ideas in course books or articles often set me off on long chains of thought of my own.

D17 When I read, I examine the details carefully to see how they fit in with what's being said.

Strategic Approach

T03. I organise my study time carefully to make the best use of it.

T05. I work steadily through the term or semester, rather than leave it all until the last minute.

T07. I'm pretty good at getting down to work whenever I need to.

T09. I put a lot of effort into studying because I'm determined to do well.

T11. I don't find it at all difficult to motivate myself.

T13. I think I'm quite systematic and organised when it comes to revising for exams.

Surface Approach

S01. I often have trouble in making sense of the things I have to remember

S04. There's not much of the work here that I find interesting or relevant.

S08. Much of what I'm studying makes little sense: it's like unrelated bits and pieces.

S14. Often I feel I'm drowning in the sheer amount of material we're having to cope with.

S16 I'm not really sure what's important in lectures, so I try to get down all I can.

S18. I often worry about whether I'll ever be able to cope with the work properly.

Appendix 3 SETLQ (Shortened version*)
Experiences of Teaching and Learning Questionnaire

This questionnaire has been designed to allow you to describe, in a systematic way, your reactions to the course you have been studying and how you have gone about learning it. There are a series of questions, some of which overlap so as to provide good overall coverage of different experiences. Most of the items are based on comments made by other students. Please respond truthfully, so that your answers describe your **actual** experiences of this **particular course** or module, working your way through the questionnaire **quickly**. It is important that you respond to **every** item, even if that means using the 'unsure' category. Please circle the appropriate number to indicate your response.

5 means agree (3) 4 = agree somewhat (3?) 2 = disagree somewhat (7?) 1 = disagree 7).

Try not to use 3 = unsure (??), unless you really have to, or if it cannot apply to you or your course.

	3	3?	??	7?	7
Aims and congruence					
1. It was clear to me what I was supposed to learn in this course unit.	5	4	3	2	1
2. The topics seemed to follow each other in a way that made sense to me.	5	4	3	2	1
3. What we were taught seemed to match what we were supposed to learn.	5	4	3	2	1
4. The handouts and other materials we were given helped me to understand the unit.	5	4	3	2	1
5. I could see how the set work fitted in with what we were supposed to learn.	5	4	3	2	1
Choice allowed					
6. We were given a good deal of choice over how we went about learning.	5	4	3	2	1
7. We were allowed some choice over what aspects of the subject to concentrate on.	5	4	3	2	1
Teaching and learning					
8. On this unit, I was prompted to think about how well I was learning and how I might improve.	5	4	3	2	1
9. The teaching encouraged me to rethink my understanding of some aspects of the subject.	5	4	3	2	1
10. This unit has given me a sense of what goes on 'behind the scenes' in this subject area.	5	4	3	2	1
11. The teaching in this unit helped me to think about the evidence underpinning different views.	5	4	3	2	1
12. This unit encouraged me to relate what I learned to issues in the wider world.	5	4	3	2	1
Set work, feedback, and assessment					
13. It was clear to me what was expected in the assessed work for this course unit.	5	4	3	2	1
14. I was encouraged to think about how best to tackle the set work.	5	4	3	2	1
15. The feedback given on my work helped me to improve my ways of learning and studying.	5	4	3	2	1
16. Staff gave me the support I needed to help me complete the set work for this course unit.	5	4	3	2	1
17. The feedback given on my set work helped to clarity things I hadn't fully understood.	5	4	3	2	1
18. You had really to understand the subject to get good marks in this course unit.	5	4	3	2	1
19. To do well in this course unit, you had to think critically about the topics.	5	4	3	2	1
Staff enthusiasm and support from both staff and students					
20. Staff tried to share their enthusiasm about the subject with us.	5	4	3	2	1
21. Staff were patient in explaining things which seemed difficult to grasp.	5	4	3	2	1
22. Students supported each other and tried to give help when it was needed.	5	4	3	2	1
23. Talking with other students helped me to develop my understanding.	5	4	3	2	1
Interest and enjoyment generated by the course					
24. I found most of what I learned in this course unit really interesting.	5	4	3	2	1
25. I enjoyed being involved in this course unit.	5	4	3	2	1

Demands made by the course or module

In this section, please tell us how easy or difficult you found different aspects of **this course unit**.

√ = *very easy* √***?*** = *fairly easy* ***??*** = *unsure/not applicable* X***?*** = *fairly difficult* X = *very difficult*

		3	3*?*	*??*	7*?*	7
a.	What I was expected to know to begin with.	5	4	3	2	1
b.	The rate at which new material was introduced.	5	4	3	2	1
c.	The ideas and problems I had to deal with.	5	4	3	2	1
d.	The skills or technical procedures needed in this subject.	5	4	3	2	1
e.	The amount of work I was expected to do.	5	4	3	2	1
f.	Working with other students.	5	4	3	2	1
g.	Organising and being responsible for my own learning.	5	4	3	2	1
h.	Communicating knowledge and ideas effectively.	5	4	3	2	1
i.	Tracking down information for myself.	5	4	3	2	1
j.	Information technology/computing skills (e.g. WWW, email, word processing).	5	4	3	2	1

What you have learned from this course or module

Now we would like to know how much you feel you have gained from studying **this course unit**.

3 = *a lot* 3*?* = *quite a lot* *??* = *unsure/not applicable* 7*?* = *not much* 7 = *very little*

		3	3*?*	*??*	7*?*	7
a.	Knowledge and understanding about the topics covered.	5	4	3	2	1
b.	Ability to think about ideas or to solve problems.	5	4	3	2	1
c.	Skills or technical procedures specific to the subject.	5	4	3	2	1
d.	Ability to work with other students.	5	4	3	2	1
e.	Organising and being responsible for my own learning.	5	4	3	2	1
f.	Ability to communicate knowledge and ideas effectively.	5	4	3	2	1
g.	Ability to track down information in this subject area.	5	4	3	2	1
h.	Information technology/computing skills (e.g. WWW, email, word processing).	5	4	3	2	1

Self-rating of academic progress

Finally, how well do you think you're doing in this course unit as a whole? Please try to rate yourself **objectively**, based on any marks, grades or comments you have been given.

very well		well		quite well		about average		not so well			rather badly
9	8		7		6		5		4	3	2	1

Please check back to make sure that you have answered every question.

Thank you very much for spending time completing this questionnaire: it is much appreciated.

Scoring Procedure for SETLQ (Short Version)

For most of the items in the questionnaires, students respond on a 1 – 5 scale (5=high). The exception is the item asking about students' self-rating which has a 1 – 9 scale. Except for this last scale, the subscales are formed by adding together the responses on the items in that subscale and dividing the total by the number of items in that scale to give a score out of 5. Scoring can be carried out by computer, using a program such as SPSS. Each item is set as a variable and then a subscale total is produced by creating a new variable by summing the items.

For the set of items on the first page - experiences of teaching and learning - the scales are shown there. Scales for the second page are indicated below.

Perceived easiness of demands made

very easy = 5, fairly easy = 4, unsure/not applicable = 3, fairly difficult = 2, very difficult = 1

Prior knowledge

a. What I was expected to know to begin with.

Pace

b. The rate at which new material was introduced

Academic difficulty

c. The ideas and problems I had to deal with

d. The skills or technical procedures needed in this subject

Workload

e. The amount of work I was expected to do

Generic skills

f. Working with other students

g. Organising and being responsible for my own learning

h. Communicating knowledge and ideas effectively

Information skills

i. Tracking down information for myself

j. Information technology/computing skills (e.g. WWW, email, word processing)

Knowledge and learning acquired

a lot = 5, quite a lot = 4, unsure/not applicable = 3, not much = 2, very little = 1

Knowledge and subject-specific skills

a. Knowledge and understanding about the topics covered

b. Ability to think about ideas or to solve problems

c. Skills or technical procedures specific to the subject.

Generic skills

d. Ability to work with other students

e. Organising and being responsible for my own learning

f. Ability to communicate knowledge and ideas effectively

Information skills

g. Ability to track down information in the subject area

h. Information technology/computing skills (e.g. WWW, email, word processing)
